

CLAIMS

1. A method of selecting a measuring method by selecting one of two measuring methods for use in an ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and a transit time method for a flow rate measurement, comprising:
 - a determining step of determining a current measuring method;
 - 10 a determining step of determining reliability of a reception wave; and
 - a selecting step of selecting a measuring method different from the current measuring method when it is determined that the reliability of the reception wave is insufficient.
- 15 2. The method according to claim 1, wherein:
 - the determining step comprises:
 - a step of obtaining a value as an index of reliability of the reception wave; and
 - 20 a step of determining whether or not the value as the index is smaller than a registered set value; and
 - the selecting step comprises a step of determining
 - 25 that reliability is not sufficient when the value as

the index is smaller than the set value.

3. The method according to claim 2, wherein:

when the current measuring method determined in
5 the determining step is the pulse Doppler method, the
value as the index is an amplitude value of the reception
wave; and

the set value is a smallest acceptable amplitude
value of a reception wave in the pulse Doppler method.

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4. The method according to claim 2, wherein:

when the current measuring method determined in
the determining step is the pulse Doppler method, the
value as the index is a ratio of an amplitude value of
15 a reception wave to a predetermined amplitude value set
in advance; and

the set value is associated with the ratio.

5. The method according to claim 2, wherein:

20 when the current measuring method determined in
the determining step is the pulse Doppler method, the
value as the index is a power spectrum of a Doppler
frequency obtained by performing a Fourier transform
on the reception wave; and

25 the set value is a predetermined power value.

6. The method according to claim 2, wherein:

when the current measuring method determined in the determining step is the pulse Doppler method, the value as the index is a ratio of a power spectrum of a Doppler frequency obtained by performing a Fourier transform on the reception wave to a predetermined power value; and

the set value is associated with the ratio.

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7. The method according to claim 2, wherein:

when the current measuring method determined in the determining step is the transit time method, the value as the index is a ratio of a transmission wave amplitude to a maximum amplitude of the reception wave; and

the set value is associated with the ratio.

8. The method according to claim 2, wherein:

when the current measuring method determined in the determining step is the transit time method, the value as the index is a ratio of a power spectrum of a transmission frequency contained in the reception wave obtained by performing a Fourier transform on the reception wave to a predetermined power value; and

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the set value is associated with the ratio.

9. The method according to claim 1, wherein:

when the current measuring method determined in
5 the determining step is the pulse Doppler method, the
determining step determines a measurement point in a
status in which a measurement can be correctly performed
at present, and counts the number of the correct
measurement points: and

10 the selecting step changes the method to the
transit time method when the obtained number of correct
measurement points is smaller than a first threshold
registered in advance.

15 10. The method according to claim 9, wherein

the determining step obtains the number of times
in which a waveform of the reception wave is not changed
continuously for each measurement point, and determines
as the correct measurement point a measurement point
20 at which the obtained number of times is smaller than
a predetermined second threshold.

11. The method according to claim 9, wherein

The determining step obtains a current velocity
25 of flow for each measurement point, obtains an average

- value of velocity of flow obtained up to the last time, obtains a difference between the obtained current velocity of flow and the average value, determines whether or not the difference is smaller than a
5 predetermined third threshold, and defines a measurement point having the difference smaller than the predetermined third threshold as the correct measurement point.
- 10 12. The method according to claim 9, wherein
the determining step obtains a Doppler shift based on the reception wave for each measurement point, obtains an average value of Doppler shifts obtained up to the last time, obtains a difference between the
15 obtained Doppler shift and the average value, and defines a measurement point having the difference smaller than a predetermined fourth threshold as the correct measurement point.
- 20 13. A method of selecting a measuring method by selecting one of two measuring methods for use in an ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and a transit time method for a flow rate measurement, comprising:
25 a determining step of determining a current

measuring method;

a determining step of determining reliability of a reception wave; and

a selecting step of selecting a measuring method
5 different from the current measuring method when it is
determined that the reliability of the reception wave
is insufficient, and when it is determined that the
reliability of the reception wave is sufficient,
obtaining a value as an index of reliability of a
10 reception wave in each of the pulse Doppler method and
the transit time method, comparing the values as the
indexes of the two measuring methods, and selecting a
measuring method having a larger value as the index.

15 14. The method according to claim 13, wherein

a value as an index of reliability of a reception
wave in the transit time method is a weighted and added
value between a ratio between a transmission wave
amplitude and a maximum amplitude of a reception wave
20 and a ratio between frequency power of a transmission
wave and a reception wave.

15. The method according to claim 13, wherein

a value as an index of reliability of a reception
25 wave in the pulse Doppler method is a weighted and added

value of a ratio of an amplitude of a reception wave to a predetermined amplitude value, and a ratio of a power spectrum of a Doppler frequency to a predetermined power value.

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16. The method according to claim 13, wherein the method selecting step further comprises:

a step of determining whether or not a value of the index having a larger value as a result of the comparison is larger than a predetermined value; and

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a step of outputting information about abnormality when the value is smaller than the predetermined value.

15 17. An ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and a transit time method for a flow rate measurement, comprising:

a determination unit determining a current measuring method;

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a determination unit determining reliability of a reception wave; and

a selection unit selecting a measuring method different from the current measuring method when it is determined that the reliability of the reception wave

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is insufficient.

18. An ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and
5 a transit time method for a flow rate measurement, comprising:

a determination unit determining a current measuring method;

a determination unit determining reliability of a
10 reception wave; and

a selection unit selecting a measuring method different from the current measuring method when it is determined that the reliability of the reception wave is insufficient, and when it is determined that the
15 reliability of the reception wave is sufficient, obtaining a value as an index of reliability of a reception wave in each of the pulse Doppler method and the transit time method, comparing the values as the indexes of the two measuring methods, and selecting a
20 measuring method having a larger value as the index.

19. A computer-readable recording medium storing a program used to direct a computer of an ultrasonic flowmeter capable of applying both a pulse Doppler
25 method for a flow rate measurement and a transit time

method for a flow rate measurement to realize:

a function of determining a current measuring method;

a function of determining reliability of a
5 reception wave; and

a selecting function of selecting a measuring method different from the current measuring method when it is determined that the reliability of the reception wave is insufficient.

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20. A computer-readable recording medium storing a program used to direct a computer of an ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and a transit time

15 method for a flow rate measurement to realize:

a function of determining a current measuring method;

a function of determining reliability of a reception wave; and

20 a function of selecting a measuring method different from the current measuring method when it is determined that the reliability of the reception wave is insufficient, and when it is determined that the reliability of the reception wave is sufficient,
25 obtaining a value as an index of reliability of a

reception wave in each of the pulse Doppler method and the transit time method, comparing the values as the indexes of the two measuring methods, and selecting a measuring method having a larger value as the index.

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21. A program used to direct a computer of an ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and a transit time method for a flow rate measurement to realize:

10 a function of determining a current measuring method;

a function of determining reliability of a reception wave; and

a selecting function of selecting a measuring
15 method different from the current measuring method when it is determined that the reliability of the reception wave is insufficient.

22. A program used to direct a computer of an
20 ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and a transit time method for a flow rate measurement to realize:

a function of determining a current measuring method;

25 a function of determining reliability of a

reception wave; and

a function of selecting a measuring method different from the current measuring method when it is determined that the reliability of the reception wave is insufficient, and when it is determined that the reliability of the reception wave is sufficient, obtaining a value as an index of reliability of a reception wave in each of the pulse Doppler method and the transit time method, comparing the values as the indexes of the two measuring methods, and selecting a measuring method having a larger value as the index.

23. An electronic device for use with an ultrasonic flowmeter capable of applying both a pulse Doppler method for a flow rate measurement and a transit time method for a flow rate measurement, comprising:

a determination unit determining a current measuring method;

a determination unit determining reliability of a reception wave; and

a selection unit selecting a measuring method different from the current measuring method when it is determined that the reliability of the reception wave is insufficient.